

Microstrip Antenna Arrays with Parasitic Elements
(Cooperative Agreement NCC 3-126)

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Final Report

Submitted to
NASA Lewis Research Center

By

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July 1996

I. DURATION OF GRANT

The grant started in February 1989 and ended in April 14, 1996. It consisted of the original one-year grant and seven supplements.

II. PERSONNEL INVOLVED IN THE RESEARCH

The grant was in the form of a Co-operative Agreement. The personnel involved included Dr. R. Q. Lee of NASA Lewis Research Center, Dr. K. F. Lee, Mr. Timothy Talty and Mr. Douglas Walcher of the University of Toledo. Mr. Talty and Mr. Walcher were students supported by the grant. Mr. Talty obtained his M.S.E.E. degree in August 1990 and will receive his Ph.D. degree in August 1996. Mr. Walcher received his M.S.E.E. degree in June 1996.

III. RESULTS OBTAINED

The research was concerned with using parasitic elements to improve the bandwidth, gain and axial ratio characteristics of microstrip antennas and arrays. Significant improvements in these characteristics were obtained using stacked and coplanar parasitic elements. Our research in this area is widely recognized in the microstrip antenna community. Details of our results are described in the Journal articles listed in Section IV.

IV. PUBLICATIONS

A total of 16 Journal papers and 17 Conference papers were published on research supported by the grant over the years. These are listed on the next 4 pages. Since copies of these publications were submitted with previous performance reports, they are not enclosed with this report.

JOURNALS

R.Q. Lee and K.F. Lee, Parasitic size and superstrate effects on electromagnetic coupled patch antennas, Electromagnetics, Vol. 9, pp. 395-404, 1989.

R.Q. Lee, T. Huynh and K.F. Lee, Experimental study of the cross polarization characteristics of rectangular patch antennas, Microwave and Optical Technology Letters, Vol. 2, pp. 247-460, 1989.

K.R. Lee, R.Q. Lee and T. Talty, Microstrip subarray with coplanar and stacked parasitic elements, Electronics Letters, Vol. 68, pp. 431-438, 1990.

R. Q. Lee and K.F. Lee, A 16 x 16 microstrip array of electromagnetically coupled patches operating in the high gain region, Microwave and Optical Technology Letters, Vol. 3, pp. 199-200, 1990.

R.Q. Lee and K.F. Lee, Experimental study of the two-layer electromagnetically coupled rectangular patch antenna, IEEE Transactions on Antennas and Propagation, 38(8): 1298-1302, 1990.

R.Q. Lee, T. Talty and K.F. Lee, Circular polarization characteristics of stacked microstrip antenna, Electronics Letters, 26(18): 2109-2110, 1990.

R.Q. Lee, T. Talty and K.F. Lee, Mutual coupling between electromagnetically coupled rectangular patch antennas, Electronics Letters, 27(6): 532-533, 1991.

T. Huynh, K.F. Lee, S.R. Chebolu and R.Q. Lee, Mutual coupling between rectangular microstrip patch antennas, Microwave and Optical Technology Letters, Vol. 5(11), pp. 572-576, Oct. 1992.

T. Huynh, K.F. Lee, S. R. Chebolu and R. Q. Lee, Mutual coupling between rectangular microstrip antennas, Microwave and Optical Technology Letters, Vol. 5(11), pp. 572-576, Oct. 1992.

W. Chen, K.F. Lee and R.Q. Lee, Spectral domain moment method analysis of coplanar microstrip parasitic subarrays, Microwave and Optical Technology Letters, Vol. 6(3), pp. 157-163, March 1993.

W. Chen, K.F. Lee and R.Q. Lee, Input impedance of coaxially-fed rectangular microstrip antennas on electrically thick substrate, Microwave and Optical Technology Letters, Vol. 6(6), pp. 387-390, May 1993.

W. Chen, K.F. Lee, J.s. Dahele, R.Q. Lee, CAD formulas for resonant frequencies of TM_{01} and TM_{10} modes of rectangular patch antenna with superstrate Journal of Microwave and Millimeter Wave Computer Aided Engineering, Vol. 3, pp. 340-349, 1993.

W. Chen, K.F. Lee, R.Q. Lee, Spectral domain full-wave analysis of the input impedance of coaxially-fed rectangular microstrip antennas, Journal of Electromagnetic Waves and Applications, Vol. 8, No. 2, pp. 249-272, 1994.

K.F. Lee, S.R. Chebolu, W. Chen, R.Q. Lee, On the role of substrate loss tangent in the cavity model theory of microstrip patch antennas, IEEE Transactions on Antennas and Propagation, Vol. 42, No. 1, pp. 110-112, 1994.

K.F. Lee, W. Chen, R. Q. Lee, Studies of stacked electromagnetically coupled patch antenna, Microwave and Optical Technology Letters, Volume 8, No. 4, pp. 212-215, 1995.

K.F. Lee, W. Chen, K.M. Luk, K.F. Tong, R.Q. Lee, Microstrip Antennas in multi-dielectric media Microwave and Optical Technology Letters, Volume 9, No. 2, pp. 149-153, 1995.

CONFERENCES

- K.F. Lee, R.Q. Lee and T. Talty, Parasitic subarray combining coplanar and multi-layer geometrics, IEEE/AP-S International Symposium Digest, pp. 1124-1127, 1990.
- R.Q. Lee, K.F. Lee and A.J. Zaman, An experimental investigation of a 16x16 microstrip array with stacked parasitic elements. IEEE/AP-S International Symposium Digest, pp. 1766-1769, 1990.
- R. Q. Lee, T. Talty and K.F. Lee, Circular polarization characteristics of parasitic microstrip antennas, IEEE/AP-S International Symposium Digest, pp. 310-313, 1991.
- R.Q. Lee, T. Talty and K.F. Lee, Measured mutual coupling between two-layer electromagnetically coupled patch antennas, IEEE/AP-S International Symposium Digest, pp. 1364-1367, June 1991.
- R.Q. Lee, K.F. Lee, T. Talty and Z. Fan, Some recent studies of microstrip antennas with parasitic elements, PIERS 1991 Proceedings, p. 602. (Invited paper).
- S.R. Chebolu, K.F. Lee and R. Q. Lee, Comparison of rectangular and triangular microstrip arrays, IEEE/AP-S International Symposium Digest, pp. 163-166, July 1992.
- T. Huynh, K.F. Lee and R. Q. Lee, Mutual Coupling between rectangular microstrip patch antennas. IEEE/AP-S International Symposium Digest, pp. 1186-1189, July 1992.
- W. Chen, K.F. Lee and R.Q. Olee, Moment method analysis of coplanar parasitic subarrays, IEEE/AP-S International Symposium Digest, pp. 1927-1930, July 1992.
- W. Chen, K.F. Lee, J.S. Dahele and R.Q. Lee, Microstrip antennas with multi-dielectric layers, Proceedings of the 1993 URSI Radio Science Meeting, p. 17.
- W. Chen, K.F. Lee and R.Q. Lee, Effect of substrate thickness on input impedance of coaxially-fed rectangular patch antennas, IEEE/AP-S International Symposium Digest, pp. 1200-1203, 1993.
- W. Chen, K.F. Lee, J.S. Dahele and R.Q. Lee, CAD formula for resonant frequency of the rectangular microstrip antenna with a dielectric cover, Proceedings of the 8th International Conference on Antennas and Propagation, pp. 550-553, 1993.
- W. Chen, K.F. Lee, R.Q. Lee, Studies of stacked electromagnetically coupled patch antennas, Proceedings of 1994 URSI Radio Science Meeting, p. 225.

R.Q. Lee, M. Zimmerman, K.F. Lee, Enhancement of array gain with stacked parasitic elements. IEEE/AP-S International Symposium Digest, pp. 468-471, 1994.

R.Q. Lee, K.F. Lee, Characteristics of a stacked microstrip antenna with an embedded parasitic element, IEEE/AP-S International Symposium Digest, pp. 2108-2111, 1995.

K.F. Lee, W. Chen, R.Q. Lee, Effect of superstrate thickness and permittivity on stacked electromagnetic coupled antennas, Proceedings of 1995 URSI Radio Science Meeting, p. 209.

D. A. Walcher, R.Q. Lee, K.F. Lee, Microstrip antenna receiving array operating in the Ku band, IEEE/AP-S International Symposium Digest, 1996.

R. Q. Lee

K.F. Lee, F. Kollarits, W. Chen, Effect of superstrate thickness and permittivity on coplanar microstrip parasitic subarrays, Proceedings of 1996 URSI Radio Science Meeting.

V. ATTACHMENT

After the last performance report submitted in December 1995, Mr. Douglas Walcher completed his thesis and was awarded the M.S.E.E. degree in June 1996. A copy of his thesis is attached to this report.